Optimizing the Performance of Hybrid Software Defined Network (SDN) through Metaheuristic Algorithms

SHORT SYNOPSIS

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Certificate

I hereby declare that the short synopsis "**Optimizing the Performance of Hybrid Software Defined Network (SDN) through Metaheuristic Algorithms**" being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in Computer Science & Engineering under Faculty of Engineering and Technology of Manav Rachna International Institute of Research & Studies, Faridabad during the academic year 2022-23.

It is a bonafide record of original work carried out under the supervision of **Prof. (Dr.) Brijesh Kumar** and has not been submitted in full or part to any other university or institute for degree or diploma. Further, it is certified that short synopsis is plagiarism free and proof has been submitted.

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ABSTRACT

Software-Defined Networking (SDN) is a promising network architecture that provides a programmable, flexible, and dynamic network infrastructure. SDN is an essential service for users of hybrid and large networks. The open flow-based protocol is crucial in enhancing the conventional or hybrid network. The open flow-based protocols are not implemented in all the network devices. Most organizations rely on single-vendor support (Hand and Keller, 2014). But now it looks like the area of the open-flow protocol will be decisive because it belongs to the open community. Soon, the monopoly of the single provider of support devices will cease. When all Original Equipment Manufacturer networks implement the open-flow based protocol devices, SDN becomes a robust networking technology. The three network planes/layers that makeup Software Defined Networking (SDN) are the data, control, and management planes.

The main distinction between traditional and SDN networks is how data packets are managed. The significant challenge of rebuilding the hybrid network nodes with the SDN switches becomes very costly, and no organization wants any expensive network implementation plan. The aim of any network designer should be economical and quality of services network. SDN should be implemented gradually, so it does not become costly. For that, it needs to identify a few points in the existing network where open-flow-based switches can be installed, and these devices provide a global view of all networks using the Open-Shortest-Path-First (OSPF) protocol. Thus, the SDN may be implemented gradually to improve the network performance and maximize the benefits achievable from SDN. This research work is aimed to gain performance by using two strategic approaches using gradual induction of SDN in the existing hybrid networks implemented using heterogeneous technologies from different OEMs for economically viable reasons and Optimizing the Performance of SDN controller using the Metaheuristic Algorithms. However, deploying SDN hybrid networks, which combine traditional and SDN technologies, faces significant challenges, including network performance optimization. Metaheuristic algorithms have shown promising results in optimizing the performance of SDN hybrid networks. These algorithms can be used to optimize various aspects of SDN hybrid networks, including the placement of SDN-enabled switches and the routing of traffic between them. Further research

is needed to explore the effectiveness of other metaheuristic algorithms and their potential applications in SDN hybrid networks.

The proposed algorithm integrates ant colony optimization and particle swarm optimization etc., to solve the network optimization problem. The algorithm aims to minimize the end-to-end delay and maximize the network throughput by optimizing the placement of SDN controllers and routing network traffic. The proposed algorithm uses various simulation scenarios and compares its performance with other optimization algorithms.

Keywords: Northbound and Southbound Interface, Software Defined Networks (SDN), Management plane, control plane, Data plane, and Open flow-based protocol devices, Metaheuristic algorithms.

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1. Introduction

Software-defined networking (SDN) components are the data plane, management plane, and control plane. The conventional network design may be replaced by separating the control plane from the network devices and connecting with the data plane. The data plane is also called a southbound interface like network switches; this equipment works to send the data as per the rules defined in the control plane; figure-1 shows the three layers of software-defined networking. The three layers of SDN are further divided into two interfaces, namely, called the northbound interface and the southbound interface. Northbound boundary lies among the SDN control and management plane. Saraswat *et al.*, (2019) The southbound interface interacts with the control and data planes and uses the open flow-based protocol to route the rules applied by the SDN control plane to the layer two devices. Besides the above, SDN also works on virtual systems, servers, and storage. SDN makes the job work significantly more manageable for the network administrators. Using SDN, the control plane administrator can apply/change/modify the new network rules for the complete network equipment; otherwise, the conventional network administrator needs to configure the equipment one by one manually. Horvath, Nedbal and Stieninger, (2015) SDN control plane is programmable and runs automatically once configured to send the data via southbound layer two devices as per the rules defined in the management plane. However, it is challenging to apply when network topology updates frequently or increases with different types of layer two devices. Abuarqoub, (2020) Bishla and Kumar, (2020). The SDN network design sometimes faces performance challenges while the network scales up.

1.1 Management Plane: The northbound interface connects to the management and control plane. The control plane has the rules, and the management plane has the application and services. Since the management plane is programmable, a network overall configuration can be set, and access from their control plane further forward the rules to the data plane.

1.2 Control Plane: It is the crucial middle layer of the SDN; the control plane layer makes the SDN word because all rules and logic are inside the control plane that decides how the network will behave and the data will transmit. It is the vital layer of the SDN. The network designer applies the rules and logic in this layer, connecting both the interfaces, i.e.,

northbound and southbound. The control plane may have more than one management plane. Control plane forward the rules to the data plane using the southbound interface where all network devices reside. The data plane job is to forward data packets in accordance with control plane guidelines.

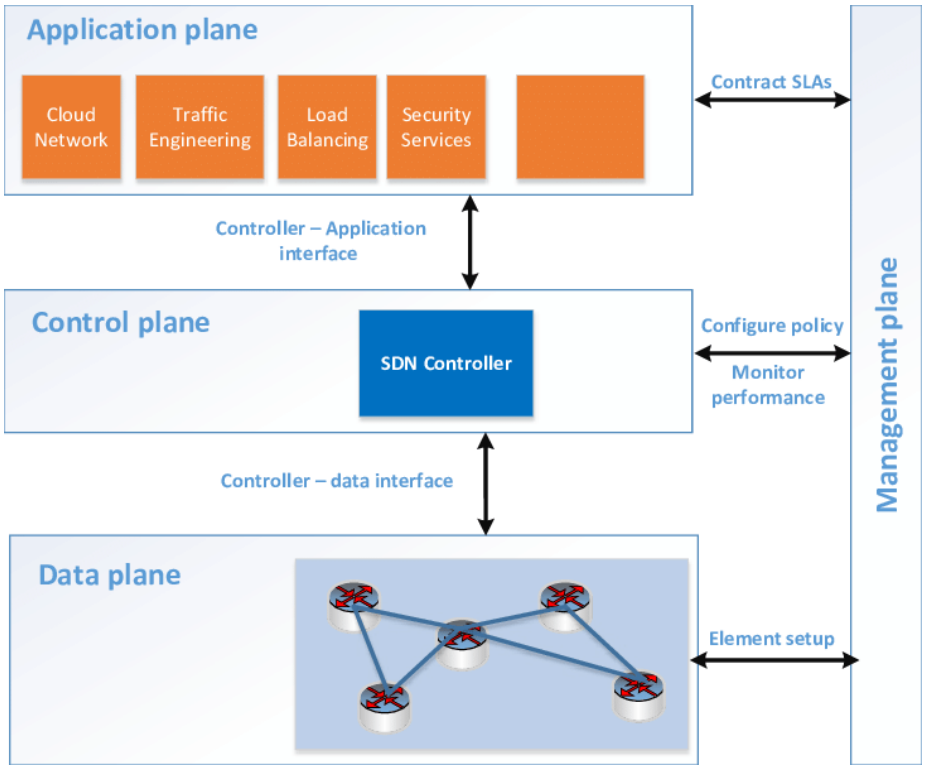

Figure1: SDN Architecture

Source: Cabaj, SDN Architecture Impact on Network Security. 10.15439/2014F473. Cabaj et al., (2014)

1.3 Data Plane: It is the third layer in the SDN architecture. All network equipment, like layer two/three network switches and routers, reside in the data plane. The data plane gets the instruction from the control plane, where the data packet needs to be forwarded. The data plane follows the instructions provided by the control plane; hence it is a very dependent layer in SDN architecture. Kaljic *et al.*, (2019) The data plane connected with the control plane using the southbound interface. The southbound interface displays the physical network equipment in its entirety.

Software Defined Networking (SDN) has revolutionized the networking industry by providing centralized control and programmability to network infrastructure. However, implementing SDN in hybrid networks - networks that consist of both traditional (non-SDN) and SDN-enabled devices - presents unique challenges. One such challenge is optimizing the network's performance, which requires balancing the traffic between conventional and SDN-enabled devices while ensuring the network meets its performance objectives.

SDN Hybrid Networks: SDN hybrid networks combine traditional networking technologies and SDN. These networks use legacy and SDN-enabled switches to provide SDN flexibility and scalability while maintaining standard network stability and reliability. However, the performance of SDN hybrid networks can be affected by various factors, such as the placement of SDN-enabled switches and traffic routing between them. Metaheuristic algorithms are optimization algorithms that are inspired by natural phenomena, such as genetic algorithms, particle swarm optimization and ant colony optimization. These algorithms have been shown to be effective in optimizing complex problems, including network optimization problems.

Metaheuristic algorithms, such as genetic algorithms, particle swarm optimization, and simulated annealing, are powerful optimization techniques that have been successfully applied in various domains. In recent years, researchers have explored the use of metaheuristic algorithms to optimize the performance of SDN hybrid networks. These algorithms can be used to optimize a range of network performance metrics, such as latency, throughput, and packet loss, by dynamically adjusting the routing paths and flow rates through the network.

SDN has covered many areas, but still, plenty of work needs to be done based on artificial intelligence techniques. The primary difference between an SDN-based and a regular network is how to regulate the data packets.

2. Literature Review

The performance of SDN networks can be affected by various factors, including traffic patterns, network topology, configuration parameters, etc. The Metaheuristic algorithm is a promising approach to optimizing the performance of SDN hybrid networks. In the literature review, discuss the work done by the various authors and nearby areas to maximize SDN hybrid network performance through metaheuristic algorithms.

Khaled et al, (2018) proposed a hybrid optimization algorithm that combines a genetic algorithm and simulated annealing to optimize the placement of SDN-enabled switches in SDN hybrid networks. The proposed algorithm by the author improves the network performance by reducing the delay and improving the network throughput.

Li et al, (2019) proposed a particle swarm optimization algorithm to optimize traffic routing in SDN hybrid networks. The proposed algorithm shows that the network performance increased by reducing the delay in transmission.

Similarly, Huang et al, (2020) proposed an ant colony optimization algorithm to optimize the placement of SDN-enabled switches in SDN hybrid networks. The proposed algorithm by the author in this paper shows that the gradual replacement of the SDN-enabled switches can reduce the cost and performance increase by decreasing the delay in transmission. Still, the global view is not as per expectations.

Abdelrahman, (2020) Topology and mechanisms-based scalability issues. The author talks about the issues of the scalability of the SDN control plane. The steps to categorize the current methods used to achieve high performance in the SDN control plane.

Caraguay, Lopez , & Villalba, (2013) It has stated that the open-flow-based SDN architecture provides the network administrators to program the behavior of the network. Their research is based on the evolution of SDN in recent year's analytic approach. The current research initiatives in the domain of open-flow/ SDN are compiled in this work. The authors have also described the challenges of the new technology.
Eom *et al.*, (2019) discussed the security issues in SDN like- Vulnerability Score, Network Centrality, and Attack Matrix. The systematic and thorough analysis of various interfaces,

protocols, and interfaces for SDN. In the overall Software Defined Networking design, these protocols are crucial for communication between all network layers and between network elements. Authors in this paper described the directional communication characteristics of these interfaces and then, based on the functionality, further sub-classify them.

Latif *et al.*, (2020) Discussed and reviewed the SDN challenges like Network Design, Implantation, Performance, and Verification. The authors represented a detailed survey of many research areas in Software Defined Networking architecture, implementation, and performance.

Saraswat *et al.*, (2019) Based on the SDN research directions, issues, and challenges, the paper focuses on SDN network performance, installation, evaluation, and verification. The network construction strongly emphasized elasticity, flexibility, and fault tolerance.

Sieber *et al.*, (2016) They exhibited a detailed blueprint for the SDN data plane. The proposal of future research approaches that adequately handle programmability and flexibility issues creates the conditions for progressing SDN data development and control plane development. Four categories of approaches to address the programmability and flexibility of SDN data plane issues were identified based on acknowledged key boundaries and using subjective metrics: Data plane languages and stateful data plane, respectively, deep programmability and new data plane architecture and abstractions

SDN upgrades the traditional network by separating the data center from the endpoints and enabling distributed and centralized routing to coexist in a hybrid network. Wang, He, and Su, (2017), He and Su designed SDN placement scheduling and data journey engineering methodologies in this study to experiment with the controllability and flexibility of SDN in the current hybrid network. SDN nodes were deployed to have the most effective control over the hybrid network. Assume then that SDN forwarding capabilities, together with those of current switches, may increase the network throughput through their traffic engineering concept. Traditional hybrid traffic engineering offers more excellent performance, especially in the early 70% SDN deployment network. According to assessment results using a range of topologies, SDN placement development ensures higher

controllability than the existing network (Mesh, Telstra, Ebone). This model seems to be very expensive.

In this paper, Hand and Keller, (2014) the author discussed the unique techniques for leveraging network control, open, logically centralized, and Open Flow run over the forwarding plane of proprietary devices (Cisco). In addition, the author discusses that technologies in network devices can be used to appreciate similar functionality to numerous of the new Open Flow extensions proposed recently.

3. Description of Broad Area

By separating the data plane from the control plane, the conventional network design is primarily replaced by the SDN, unlike the SDN network devices, which only have to forward the data packets following control plane instructions. The old network devices house both data and control functions.

All three layers have their specific task. The management plane has the application and services connected with the control plane using the southbound interface. The control plane is programmable, where the rule and policies of the network are defined. The network administrator can easily explain the rule and policies and manage the whole network by pushing the policy task on the data plane. The control plane and data plane are connected via a southbound interface. Simply forwarding data packets along the routes specified by the control plane is all the data plane does.

How to manage data packets is the main difference between the SDN network and the traditional network shown in below Figure 2 and Figure 3.

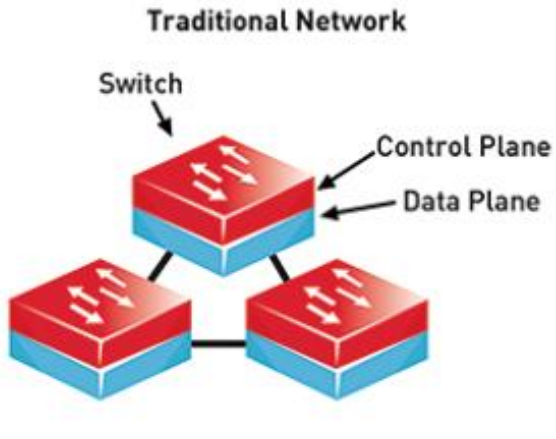

Figure: 2 Traditional Network

Image Source: https://www.commsbusiness.co.uk

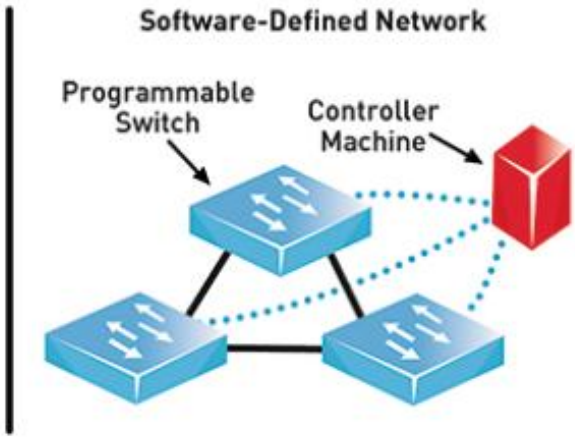

Figure: 3 Software Defined Network

Image Source: https://www.commsbusiness.co.uk

The main reasons that networks remain difficult to manage are:

- Rapidly Changing Networking State
- Low-level network devices configuration

Three Security Issues

1. Network Intrusion: Due to 3 tier architecture, it has more probability of security threat. If the centralized controller is compromised, it may impact the forwarding planes.

2. Denial of Service: It is more severe in SDN because it has centralized control. If a forwarding plane cannot match the rule for an incoming packet, then the SDN controller will keep the packet in a buffer and send a message to the controller for a suitable condition or rule. An attacker can flood a large payload that belongs to different payloads.

3. Application Trust Management: Controllers cannot distinguish between applications. New applications are easily embedded into the underlying network. New applications may not be secured enough. Therefore how managing trust in lots of applications is a major problem.

Other problems that Software Defined Networks face include: integration with existing networks, Scalability, efficiency, and improvement

SDN is also very effective in the implantation of server virtualization and data centers. An essential feature in the SDN that makes SDN the most powerful is the division of control and data plane. The control plane provides the programmable environment. But SDN also has a few limitations, like performance and scalability issues. Gelberger, Yemini, and Giladi, (2013). The scalability issue wherein after some time, when the network needs to be expanded, more SDN controller is required to distribute the traffic load; otherwise, the existing single SDN control performance will be degraded. Sometimes a single SDN controller cannot perform well in a huge network; more SDN controllers are required for load balancing. Here machine learning technique can be integrated along with the multiple SDN controllers in a huge network, wherein the control plane can predict the traffic load

and modify the path in the data plane. Machine learning technique integration with the SDN controller can improve network performance. To achieve a true SDN only, all end equipment in the data plane should follow the open flow-based protocol.

From the above fact, it has been clear that SDN implementation in the existing hybrid network is challenging at a lower cost. In the new setup, initial stage SDN implementation is easier and cheaper than existing network SDN implementation. In the existing network, there are lots of challenges; the biggest problem is heterogeneous types of devices, most of which are not supported by the open-flow-based protocol. There are multiple suggestions to implement the SDN, but none are feasible for a true SDN. Sultana *et al.*, (2019) Making middleware in the network at key nodes that connects with non-standard open flow devices using the Open-Shortest-Path-First (OSPF) protocol is one approach to implementing SDN in the hybrid network. Latif *et al.*, (2020) All kinds of network equipment support the routing table algorithm, and middleware takes advantage of them to create a global view of the physical network.

The largest problem is creating a cost-effective SDN model; if it replaces all current hardware, it becomes a very expensive solution. Since businesses never consider pricey solutions, it is up to the network designer to suggest a model that is both cost-effective and guarantees high-quality services. Tourrilhes *et al.*, (2014) It can be difficult to locate a location in the hybrid network where SDN devices can be deployed.

3.1 Challenges to implementing SDN in existing network

Software-defined networking (SDN) is a network architecture allowing network administrators to control and manage the network infrastructure programmatically. Implementing SDN in an existing network can be challenging, requiring significant changes to the underlying network infrastructure and operating network traffic. Some of the key challenges to implementing SDN in an existing network include:

- Legacy infrastructure: Many existing networks were built using legacy hardware and software incompatible with SDN. Upgrading the entire network infrastructure to support SDN can be costly and time-consuming.

- Integration with existing systems: SDN solutions must be integrated with existing systems, such as network monitoring and security tools, to ensure they continue working as intended.
- Network complexity: Large and complex networks can be challenging to manage with traditional network management tools, and SDN can introduce new complexities that must be addressed.
- Scalability: SDN solutions must scale to support growing networks and increase traffic loads without causing performance issues or downtime.
- Security: SDN can introduce new security risks, and security protocols and policies must be implemented to mitigate these risks.
- Skillset: Implementing SDN requires specialized skills and knowledge, which may not be available in-house. Training staff or hiring new employees with the necessary skills can be costly and time-consuming.
- Cost: The cost of implementing SDN can be high, as it requires new hardware, software, and personnel.

Caraguay, López and Villalba, (2013) contributed many proposals, yet we can only partially accomplish a genuine SDN. It is expensive and time-consuming to implement SDN in the current hybrid network. The majority of conventional networks likely do not support the open flow-based protocol network and instead use a variety of network devices. In that case, there is only one option for the SDN designer to implement open flow-based protocol switches in place of conventional switches, but doing so would be extremely expensive and unpopular. The designer must offer a plan to save costs and organize the Quality of Services (QoS) for the new SDN network.

To overcome the challenges of implementing SDN in the existing hybrid network, one of the authors Horvath, Nedbal and Stieninger, (2015) suggested a way in which one needs to create a middleware across the network in between the non-open flow-based network devices. In accordance with instructions, middleware will interface with the SDN control plane and manage the data.. That middleware will manage the data path based on the routing table algorithm. With the help of the routing table algorithm, middleware can generate a global view of the physical network. Most network devices support the Open Shortest Path First (OSPF) protocol, and middleware takes advantage of this for communication with non-open flow-based devices.

Other authors Younus *et al.*, (2019) also try to find a solution to execute the SDN in a live hybrid network like a "graph-based heuristic approach, unified network controller, etc.". However, the majority of solutions do not shape a true SDN. It depends on the network designer, which devices need to be replaced, or where a new open flow-based device needs to be installed; the controller may not suggest this. Refer to figure 4, In the true SDN, all switches in the network are managed and configured by the SDN. Hence, SDN can do the load distribution automatically so that performance and utilization can be increased and provide a global view of the management plane to make, change and modify the new rules and policies.

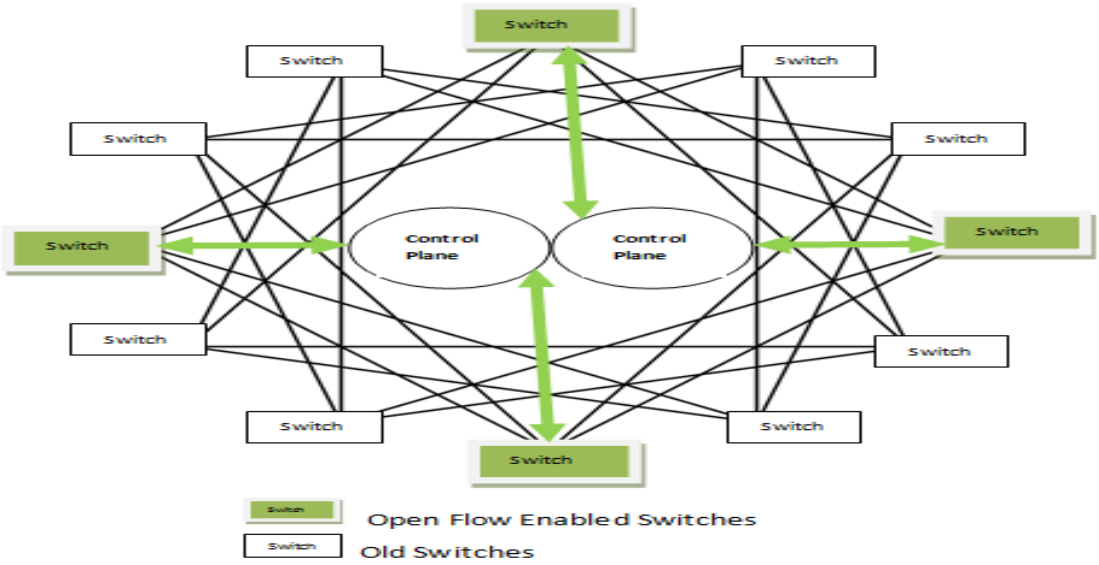

Figure 4: SDN in existing network

Implementing the SDN in an existing network requires careful planning, assessment of the network needs and capabilities, and a thorough understanding of the challenges involved. It is essential to evaluate the benefits and costs of SDN implementation carefully and develop a detailed implementation plan to ensure a successful transition.

3.2 A few observation based on the develop of Software Defined Netwrok in plane networks (non-hybrid) using the open-flow protocol (SDN-enabled-devices).

In the literature review of the SDN implementation in the existing network, many authors Pan *et al.*, (2013); Hand and Keller, (2014); Nelson *et al.*, (2015) suggested many solutions, but none defined a true SDN like "to identify the SDN based nodes; *graph-based heuristic approach, unified network controller, etc."* Authors Hong et al., (2016) used the

incremental deployment of open flow to establish a cost-effective SDN network without replacing the existing network. They closed flow Hand and Keller, (2014) and Nelson *et al.*, (2015) based algorithm and the routing OSPF protocol to interest between the existing network switches and the controller. Each device passes the information to the other, and finally, the controller creates a global view. It is challenging to maintain via controller; here, network administrators access the network via SSH or telnet commands and configure the multiple network switch in the hybrid network. In another solution author Pan *et al.*, (2013) proposed a middle layer that converts the rules the controller instructed. The middle layer, the flow adapter, has limited processing capability because it works on layer 2 of the OSI model.

3.3 A few observation based on Optimizing the Performance of Hybrid Software Defined Netwroks through Metaheuristic Algorithms

Optimizing the performance of hybrid Software Defined Netwroks through metaheuristic algorithms can involve several solutions. Here are a few examples:

- Traffic Engineering: Metaheuristic algorithms can be used to optimize traffic engineering in SDN hybrid networks. This consists of maximizing the traffic flow through the network by selecting the best paths, adjusting the bandwidth and latency of links, and balancing the load on the network. Song et al., (2022)
- Resource Allocation: Metaheuristic algorithms can also be used to optimize resource allocation in SDN hybrid networks. This involves allocating network resources such as bandwidth, CPU, and memory to the appropriate applications and services, to ensure optimal performance. Kipongo et al., (2022)
- Routing and Switching: Metaheuristic algorithms can be used to optimize routing and switching in SDN hybrid networks. This involves selecting the best path for network traffic based on network congestion, latency, and bandwidth availability. Janabi et al., (2022)
- Load Balancing: Metaheuristic algorithms can be used to optimize load balancing in SDN hybrid networks. This involves balancing the load on network resources, such as servers and switches, to ensure optimal performance and avoid congestion. Li et al., (2022)

- Quality of Service (QoS): Metaheuristic algorithms can be used to optimize QoS in SDN hybrid networks. This involves ensuring that network traffic is prioritized appropriately based on its importance to ensure optimal performance for critical applications and services. Keshari et al., (2021)

Metaheuristic algorithms can be applied to various aspects of SDN hybrid networks to optimize their performance. By using these algorithms, network administrators can make more informed decisions, automate network management tasks, and improve the overall performance of their network.

The aim is to provide an overview of the state-of-the-art in optimizing the performance of SDN hybrid networks through metaheuristic algorithms. It will discuss the different metaheuristic algorithms used in this context, the optimization objectives, and the challenges associated with using them in real-world networks. Additionally, the review of recent research that has applied metaheuristic algorithms to SDN hybrid networks highlights some of the key results and insights gained from these studies. Providing a comprehensive overview of this area aims to help researchers and practitioners better understand the potential of metaheuristic algorithms for optimizing the performance of SDN hybrid networks.

4. **Research Objectives**:

a) To identify the factors and constraints leading to the challenges for designing an efficient hybrid SDN.

b) To analyze and investigate the various performance parameters of SDN, such as bandwidth utilization, delay in transmission (latency), transmission rate, packet loss, etc.

c) To identify and analyze the challenges arising out of multiple controllers implemented in logical distributed control planes.

d) To propose and evaluate the metaheuristic algorithm to lessen the impact of the factors affecting the performance of SDN.

5. Methodology

1. Identify the gaps for future improvement in the area of performance enhancement in the current hybrid network utilizing SDN by researching the literature that is already available, classifying the concerns and challenges regarding the deployment and performance of the hybrid network architecture.

2. Analyzing current protocols and methods to determine the factors, such as scalability, performance, and optimization, that have an impact on the performance of SDN architecture

3. Identification and investigation of the current methods will be done in order to address and optimize the SDN controllers for better bandwidth utilization, delay in transmission (latency), transmission rate, and packet loss.

4. Using several metaheuristic methods, like Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), and Genetic Algorithm (GA), etc. the hybrid SDN routing algorithm shall be examined and compared.

5. A framework based on the metaheuristic approach is being proposed to minimize the challenges arising out of multiple controllers implemented in a logical distributed control plane.

6. Expected Outcome of the Research

The proposed research aims to identify the challenges of designing an efficient hybrid SDN. It aims to provide a deployment model with a tradeoff between cost-effectiveness and investigating the performance analysis of SDN controllers. The outcome shall be prepared in the form of statistical data derived from the research work for different parameters like bandwidth utilization, delay in transmission (latency), transmission rate, and packet loss. In hybrid SDN, network design is carried out to enhance connection and scalability between edge switches and the controllers. Finally, using a hybrid metaheuristic algorithm to maximize convergence and decrease deployment and communication latency in the environment, several controllers are put in based on the chosen controller. An algorithm shall be derived to reduce the impact of multiple controllers implemented in a physically distributed control plane. The proposed algorithm shall optimize performance by minimizing the communication delay and propagation latency and improving the throughput and reliability of the software-defined networking. The research on optimizing the performance of SDN hybrid networks through metaheuristic algorithms can lead to several potential outcomes, such as:

- Improved network performance: Using metaheuristic algorithms can improve network performance, including increased network speed, reduced latency, and improved throughput. This could result in a more efficient and reliable network that can handle more traffic and provide better service to end-users.
- Enhanced network scalability: SDN hybrid networks are designed to be scalable, but optimizing their performance through metaheuristic algorithms can further strengthen their scalability. This could enable the network to support more devices and applications and expand its reach to new users and locations.
- Better resource utilization: Metaheuristic algorithms can help optimize network resources, such as bandwidth and computing power, leading to more efficient resource utilization. This could result in cost savings for network operators and better use of resources for end-users.
- Increased network security: SDN hybrid networks are vulnerable to cyber attacks, and optimizing their performance through metaheuristic algorithms can help

improve network security. This could include better detection and prevention of attacks, improved encryption, and enhanced security protocols.

- Advancements in metaheuristic algorithms: The research could lead to improvements in metaheuristic algorithms themselves, improving their efficiency, effectiveness, and applicability to other network optimization problems.
- Cost-effective: This research is aimed at the gradual induction of SDN in the existing hybrid networks implemented using heterogeneous technologies from different OEMs for economically viable. The model will be cost-effective to gradually implement the SDN to improve the network performance and maximize the benefits achievable from SDN.

Optimizing SDN hybrid network performance through metaheuristic algorithms can significantly contribute to networking and telecommunications, leading to better network performance, scalability, resource utilization, security, and algorithmic advancements.

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Optimizing the Performance of SDN Hybrid Networks through Metaheuristic Algorithms

SHORT SYNOPSIS

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ABSTRACT

Software-Defined Networking (SDN) is a promising network architecture that provides a programmable, flexible, and dynamic network infrastructure. That is an essential service for users of hybrid and large networks. The open flow-based protocol is crucial in enhancing the conventional or hybrid network. The open flow-based protocols are not implemented in all the network devices. Most organizations rely on single-vendor support (Hand and Keller, 2014). But now it looks like the area of the open-flow protocol will be decisive because it belongs to the open community. The domination of the sole vendor support devices soon that will over. When all Original Equipment Manufacturer networks implement the open-flow based protocol devices, SDN becomes a robust networking technology. The three network planes/layers that make up Software Defined Networking (SDN) are the data, control, and management planes.

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The main distinction between traditional and SDN networks is how data packets are managed. The significant challenge of rebuilding the hybrid network nodes with the SDN switches becomes very costly, and no organization wants any expensive network implementation plan. The aim of any network designer should be economical and quality of services network. SDN should be implemented gradually, so it does not become costly. For that, it needs to identify a few points in the existing network where open-flow-based switches can be installed, and these devices provide a global view of all networks using the Open-Shortest-Path-First (OSPF) protocol. Thus, the SDN may be implemented gradually to improve the network performance and maximize the benefits achievable from SDN. This research work is aimed to gain performance by using two strategic approaches using gradual induction of SDN in the existing hybrid networks implemented using heterogeneous technologies from different OEMs for economically viable reasons and Optimizing the Performance of SDN controller using the Metaheuristic Algorithms. However, deploying SDN hybrid networks, which combine traditional and SDN technologies, faces significant challenges, including network performance optimization. Metaheuristic algorithms have shown promising results in optimizing the performance of SDN hybrid networks. These algorithms can be used to optimize various aspects of SDN hybrid networks, including the placement of SDN-enabled switches and the routing of traffic between them. Further research is needed to explore the effectiveness of other metaheuristic algorithms and their potential applications in SDN hybrid networks.

The proposed algorithm integrates ant colony optimization and particle swarm optimization etc., to solve the network optimization problem. The algorithm aims to minimize the end-to-end delay and maximize the network throughput by optimizing the placement of SDN controllers and routing network traffic. The proposed algorithm uses various simulation scenarios and compares its performance with other optimization algorithms. The simulation results show that the proposed algorithm outperforms the different algorithms in terms of both delay and throughput. The proposed algorithm provides an effective solution for optimizing the performance of SDN hybrid networks, which can be helpful for network engineers and researchers working in SDN.

Keywords: Northbound and Southbound Interface, Software Defined Networks (SDN), Management plane, control plane, Data plane, and Open flow based protocol devices, Metaheuristic algorithms.

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